EUROPEAN PATENT APPLICATION

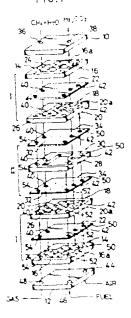
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(a) Plate type reformer.

Main units (1-l), which not ude a reforming reactor (16) and a combustor (20), both piled together having a heat conductive partition wall (22) thereceiveen, are located in a manner such that the combustor (20) sides of the main units (I, I) face each other. At an auxiliary unit (II) for supplying fuel to each combustor (20) being put between the main units (I, I). Raw material gas to be reformed is supplied to the reforming reactor (16) through a passage (35, 40) formed in each unit (I, II), and then discharged through another passage (38, 42) formed in each unit (I, III), fuel is supplied to the auxiliary unit (II) through another passage (46, 52) formed in the main unit (I) so that it may flow uniformly dispersing in the combustor (20) via the auxiliary unit (II).





EP 0 308

Plate Type Reformer

The envention related to a reformer where fuelgas was implementages is retormed to product gas and subclied to shudes fuel electroded of selsor fuel ceal systems in candour and relates to a plate type reformer where reforming relation is conducted while the tive gas is indirectly heated by burning gas which is supplied to cathodes vair electrodes of the ceals.

A fuel call excremits an electricity generating system using reverse till estro-chemical reaction of an electrolysis of water in electrolytes including carbonates, prosphorates, etc., with hydrogen gas being supplied to anodes ifter electrodes) and burning gas (Oc. COc) to cathodes cair electrodes in the cells.

The hydrogen gas, which is supplied to the anode, is obtained by supplying tueligas, such as methane, as raw material gas with the steam to the reformer, in accordance with reforming reaction which is given by the following phemical equation with catalysts:

$$GH_{\bullet} + H_{2}O \rightarrow DO + 3H_{2}$$

 $CO + H_{1}O \rightarrow CG_{2} + H_{2}$

To maintain the reforming temperature in the reformer, remaining hydrogen or carbon monoxide in the anode gas is supplied to the reformer and burned there to hear up indirectly the fuel gas to be reformed.

In such a reformer, however, air and fuel flow into a compuster of the reformer to be burned together, so that volume of the compuster has to be large, and the reformer is often too large in size. The temperature of the burned gas is as high as 1300 degrees C butil heat is transferred to the reforming gas and this structurally impossible to decrease the temperature of the burnt gas in order to match the temperature of the heat receiving gas (between 550 and 750 degrees C).

To solve these problems, plate type reformers which are compact in size, and in which uniform combustion all over the combustor is possible to achieve effective reforming, were recently proposed (see for example, Japianese Patent Application La.d Open No. 160136 1987).

A primary object of this invention is to provide a plate type reformer which enables an effective heat exchange between the burning gas and a raw material gas to be reformed at a lower temperature as hereinbefore possible.

A further object of this invention is to provide a plate type reformer which enacles undorm fuel supply to the combustor as we'll as step-by-step

templeter.

This inventor ontivides a diate type reformer continuiting plans main unito which include a computation that with an all reforming reactor their with a reforming tracklyst based together with a real conductive separator catwies the computative and blural auxiliar, units to cupply flush to the computative of the respective main units.

Further the invention provides a plate type reformer in which the compustativities surfaces of the main units face each other sandwiching an auxiliary unit prejective in thus the main units and the auxiliary unit are fixed together, and this prophas a passage to supply air for combustion to the above-mentioned compustor, a passage to exhaust paint gas from the combustor, a passage to supply the raw material gas to be reformed into the reforming reactor, a passage to draw off the reformed gas, and a passage to supply fuel to the above-mentioned distance plate.

The invention will be further described with reference to the drawings in which

Fig. 1 is a perspective view showing a part of an embodiment of this invention prior to assembling thereof:

Fig. 2 is a cross sectional view of Fig. 1 as assemble at

Fig. 3 and Fig. 4 illustrate temperature distributions of compustion gas and reforming gas getween the inlet and the outlet of the reforming reactor during heat exchange, respectively.

Fig. 5 is a pross section view of another embodiment at its central part.

As described in Fig. 1 and Fig. 2, a single segment of a plate type reformer of this invention mainly econorises two main units I, in which a reforming reaction and a combustion take place, and one auxiliary unit II, through which fuel for compustion is supplied to the main units I, with the auxiliary unit sandwiched by the main units I, and the main units I being symmetrical to each other Holders 10 and 12 are located on the exposed sides of the main units I, respectively.

The main unit I includes a reforming plate 14 in which a referming reactor 16 is provided, a combustion plate 18 in which a combustor 20 is provided, and a heat conductive separator or a heat conductive partition wall 22 located between two plates 14 and 18. A central portion of the reforming plate 14 ic hollowed out and the hollow or space 16a is filled with a reforming catalyst 24 se as to form the reforming manter 18. Similarly to the reforming plate a central parties of the combustion

distent 8 is not award out and the necessity 30s defined within the compostion plate 18 ic filled with a compostion catalyst 28 sc as it form the combostor 0

The aukiliary unit If comprises a distance plate 30 which has a scooped space 28, and two dispersion plates 34 which have a plurant, or occas 32 to supply tue, from the scooped scale 28 to the compustors 20 in the main units it with the dispersion plates being stacked onto the distance plate.

In the pile of these main units I and the auxiliar, unit II the compustion plates 18 of the main units I are located to contact with the upper and lower discersion plates 34 of the auxiliary unit II, respectively. The upper no der 10 and the rower noticer 12 for the sandwich of the upper main unit I the auxiliary unit II, and the lower main unit I are fostened by bolts and nuts, or the like (not shown).

The upper holder 10 has an inlet opening 36 for raw material gas to be reformed (Ch. + HcO). and an outlet ocening 38 for the reformed gas (Hz CO₂). The inlet 36 communicates with the reforming reactor 16 in the reforming plate 14 located thereunder, and the raw material gas to be reformed is supplied to the reforming reactor 16 in the lower main unit I through bores 40 formed within the partition plate 22, the compustion plate 18, the dispersion plate 34, and the distance plate 30. The gas so reformed flows through openings 42 formed within the partition plate 22, the combustion plate 18, the dispersion plate 34, and the distance plate 30 so that it encounters the gas reformed in the reforming reactor 16 in the upper main unit I and proceeds to the outlet opening 38 at the upper holder 10.

The lower holder 12 has an air little 44, a fuel inject 46, and a puritigas cutlet 48. Air through the air inject 44 is supplied to the combustion chamber 20 in the compustion plate 18 through openings 50 provided in the reforming plate 14 and the separator 22 of the lower main unit 1, and then from that combustion chamber 20 the air is supplied to another combustion chamber 20 in the upper main unit 1 through openings 50 of the upper and lower dispersion plates 34 and the distance plate 30.

Fuel through the fuel inlet 46 is supplied to the scooped space 28 of the distance piate 30 via openings 52 bored within the reforming plate 14, the partition piate 22, the combustion plate 18, and the dispersion plate 34 of the lower main unit I.

Exhaust gas generated in the combustor 20 in the upper main unit I flows through holes 48 formed in the dispersion plate 34 and the distance plate 30 and encounters the exhaust gas generated upon combustion in the combustion chamber 20 of the lower main unit I. After that, those exhaust gases are discharged from an exhaust opening 48 through notes \$4 pro. 3ed in the lower particip

plate CC and in the lower remind blate 14.

In the approximent shed system as to subset through the air met 44 white fue is subset through the late net 46 in the lower holder 12 and tak material gas to be reformed (CHL + holds subsided through the passinget 36 in the upper noticer 10

The air final from the armoust 44 through the noise 50 mpc the compositors 20 m be upder and lower main unit. The flue flowe into the spoced space 28 m the distance base 30 from the flue met 46 of the lower had be 12 mough the rue, passage 52 of the main unit, and then the flue flowe but of the spoced space 38 proposing through the pures 32 of the upder and diwer dispersion clates 34 into the upder and diwer dispersion clates 34 into the upder and diwer combustors 20 heat to the proposition passage 34. The flue is burned with the compusion catalyst 20 in the compusions 20 and the resulting exhaust gas is dispharged from the exhauct pus cut at 48 of the historia 12 through the roles 64.

On the other rand, the raw material gas to be reformed and subplied from the thirst 36 of the upper holder 10 flows into the reforming reactor 16 of the upper main unit 1, and a part of the gas further flows into the reforming reactor 16 of the lower main unit 1 through the holes 40. This fueligas is heated by the gas which has been burned in the combustor 20 and reaches the reaction chamber 16 through the separator 22, and is reformed to H2 and CO2 with the reforming catalyst 26 in the reforming chamber 16. The gas thus reformed is delivered outside the unit from the reformed gas outlet 38 of the upper holder 10 via the openings 42.

In the reforming process mentioned above, this system can be made compact because the reforming reactor 16 is located adjacent to the combustor 20 with the secarator 22 disposed between the reforming reactor 16 and the combustor 20 so that the reforming reactor 16 may be heated up by the burned gas generated in the combustor 20.

Since the fuel flows through the scoot edispace 28 of the distance plate 30 and the pores 32 of the dispersion plate 34, it spreads uniformly throughout the combustor 20, and the combustion of the fuel takes place gradually or stop by step, lowering the combustion temperature compared with conventional systems. It is possible to adjust the combustion temperature required by the heat receiving gas, by controlling the size and the pitch of the pores 32 in the dispersion plate 34.

Fig. 3 and Fig. 4 depict temperature distribution curves of burnt gas and heat-receiving reformed gas between the entrance and the exit of the reforming reactor, in which "X" indicates a temperature distribution curve of combusted gas, and "V" indicates the distribution curve of the gas

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reformed according to the present invention while "Z" is the temperature distribution curve of the gas compustion in a conventional system. Fig. 3 depicts distribution curved of the case where the heat exphange pathween compusted gas and heat receiving fretorming gas is performed by parallel gas frow rotaficw, and Fig. 4 heads the base of counter flow. As indicated by the curve Z, the temperature of the compusted gas in the conventional system is as high as 1800°. O at the entrance while according to the present invention, the burned gas temperature is 650°. C at the entrance and 850°. C at the entrance and 850°.

Fig. 5 shows another embodiment of the present invention. This embodiment, basically identical with the example inustrated in Figs. 1 and 2, has two porcus plates 60 each contacting to the combuster 20 side of dispersion plate 34 of the auxiliary unit II. In this example, the function of the porcus plate 60 is to further disperse the fuel flowing into the combuster 20 from the porces 32 of the dispersion plate 64. In other words, if the side and the pitch of the porces 32 in the dispersion plate 34 are determined so as not to be affected by pressure fluctuation of the fuel, the pitch becomes too large and a uniform fuel dispersion is difficult to realize. In such a case, the porous plate 60 effectively serves to make the fuel much finer.

The present invention is not restricted to the above-mentioned examples but, for instance, the positions of the pascages for air, fuel, etc. and of each injet outlet opening for fuel, the reformed gas, etc., may be changed from the positions shown in the figures. The numbers of layers of the main unit may be more than two, and accordingly, the number of auxiliary units will be increased.

Claims

1. A reformer including a reforming reactor (16) in which a raw material gas undergoes a reforming reaction in the presence of a catalyst and fuel gas is burned so that the reforming reaction temperature may be maintained at a proper level, and the burned gas may indirectly heat the raw material gas in the reforming reactor (16), characterized in that said reformer comprises: a plurality of main units (I), each main unit (I) including a combustor (20) filled with combustion catalyst (26) and a reforming reactor (19) filled with reforming catalyst with a heat conductive partition wall (22) being sandwiched between the combustor (20) and the reforming reactor (16), an auxiliary unit (II) having a fuel chamber (28) through which fuel is supplied to each compustor (20 of the main units (),, the

complication (CO) cracks of the main units. In facing each other so as to randwish the auxiliary unit (N) cetween the main units (I) an air passage (44-50) for supplying air to said compustor (CO) an exhaust baseage (48-54) for dispharging the gas burned in said computator (20) a fuel gas passage (35-40) for supplying fuel gas for reforming to the reforming reactor (16) a gas dispharge cassage (42-38) for dispharging the gas which is reformed and a fuel baseage (46, 52) for supplying the fuel to said fuel baseage (48, 52) for supplying the fuel to said fuel character (28), all the baseages (38-40, 42, 44, 46-48-50, 50) being formed within the main and auxiliary units (iii).

2. The retainment of claim 1, characterized in that the main units (1) are "coated on both sides of the auxiliary unit (1) in a way that the computator (20) of each main unit (1) faces the auxiliary unit (1), and two holders (10, 12) are provided at the excised sides of the main units (1), so that all the units (1, 1) between the holders (10, 12) are piled together as a single unit.

3 The reformer of claim 1 or 2 characterized in that the main unit (ii) includes a reforming plate (14) in which the reforming reactor (16) is formed, a combustion plate (15) in which the combustor or a combustion chamber (20) is formed, and a heat conductive partition plate (22) which is sandwiched between the reforming plate (14) and the combustion plate (18).

4. The reformer of claim 3, characterized in that the reforming reactor (16) includes the reforming plate (14) which is hollowed out at the center thereof, the hollowed space (16a) being filled with the reforming data yst (24).

5 The reformer of claim 3 or 4, characterized in that the combustor (20) includes the combustion clate (18) whose central portion is nollowed out, the hollowed space (20a) being filled with the combustion catalyst (26).

6 The reformer of any one of the foregoing claims characterized in that the auxiliary unit (ii) includes a distance plate (30) which has a scooped space (28) that serves as a fuel supply chamber (28), and two dispersion plates (34, 34) disposed on both sides of the distance plate, a piurality of pores being formed in the dispersion plate (34) so that fuel is supplied therethrough from the fuel chamber (28) to the combustor of the adjacent main unit (i).

7. The reformer of claim 6, characterized in that the main unit (I) is stacked in a manner such that the combustor (20) of the main unit (I) may be located adjacent to the dispersion plate (34), and that a holder (10, 12) is incurred on the reforming reactor (16) side of the main unit (I) so that all the units (I, II, I) may be piled as alsing all element.

8 The reformer of claim T characterized in that the raw material gas finet (38, and tille reformed gas outlet (38) are formed in one holder (10), and that supply and discharge classages (40, 42) for raw material gas to be reformed and for the reformed gas are formed in the neat conductive partition wal (22), in the obmoustion diate (18) in the distance glate (30, and in the dispersion diate (34) of the auxiliary unit (10).

9 The reformer of claim 7 characterized in that the infet openings (44, 46) for combustion air and fue gas, and the outfet opening (48) for the obmousted gas are formed in the other holder (12), that a supply bassage (44) for combustion air and a disprarge passage (54) for the exhaust gas are formed in the heat conductive cartifon wall (22), in the reforming plate (14) in the distance plate (30) and in the dispersion plate (34) of the auxiliary unit (11), and that a supply passage (52) is formed in the combustion plate (19), in the heat conductive partition wall (22), in the reforming plate (14), and in the dispersion plate (34) of the auxiliary unit (II), so as to allow the fuel gas to flow into the scooped space (28) of the distance plate (30).

10. The reformer of claim 6, characterized in that a perous plate (60) is provided on the combustor (20) side of the dispersion plate (34) in the auxiliary unit (II).

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FIG.I

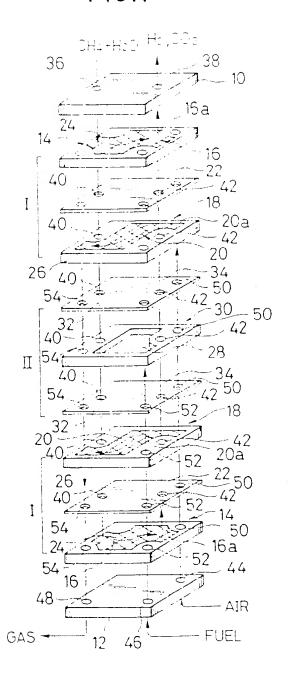


FIG.2

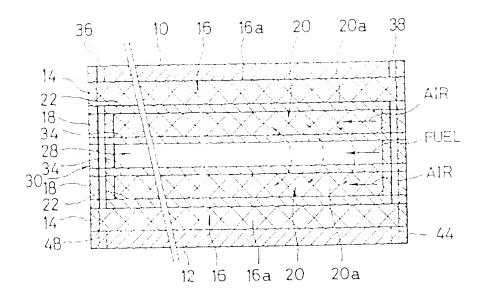


FIG.3

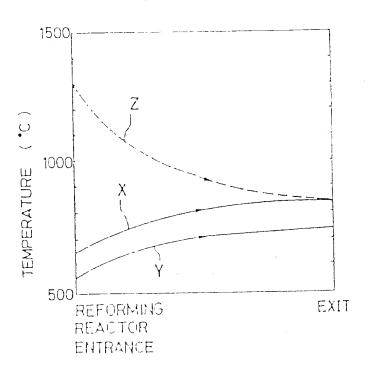


FIG.4

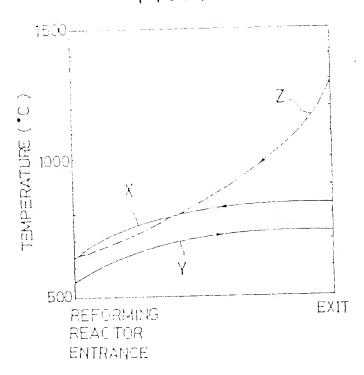
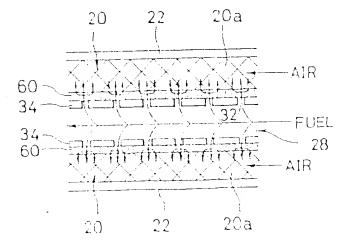


FIG.5



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EUROPEAN PATENT SPECIFICATION

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- (4) Publication of the grant of the patent 02.01.92 Bulletin 92/01
- (4) Designated Contracting States DE GB IT NE
- 🔠 References cited JP-A-62 027 305 JP-A-62 160 134 JP-A-62 160 135 JP-A-62 160 136

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- (%) Representative: Schaumburg, Thoenes & Englaender Mauerkircherstrasse 31 Postfach 86 07 48 W-8000 München 86(DE)

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Description

This in endual relates to a reformer where fact gas naw material gas is reformed to smoothly gas and explicit to an entitles meet desired the line to extend so that in a supply an armonic relates to a plate type reformer where net many readition is per ducted which the fact gas is natively beared by surfaining gas, which is solicited to capitals can evictudes of the selfs.

A fuel cell system is an electrosity generating system using represent electrosity minual reaction of an electrosis of water in most polytes including carbonates, prosprovated, etc., Act objectionals and burning supplied to an idea ideal electrosis, and burning gas (O., OC), its cathodas (an electrosis) in the cells.

The hydrogen gas, which is susplied to the anode is obtained by supplying that gas, such as methane, as raw material gas with the steam to the reformer in accordance with reforming reaction which is given by the following chemical equation with catalysts.

$$CH_{4} + H_{2}O \rightarrow CO + 3H_{2}$$

 $CO + H_{2}O \rightarrow CO_{2} + H_{2}$

To maintain the reforming temperature in the reformer, remaining hydrogen or carbon monoxide in the anode gas is supplied to the reformer and burned there to heat up indirectly the fuel gas to be reformed.

In such a refermer, however, air and fuel flow into a combunter of the reference to be burned together, so that volume of the combuster has to be large, and the reference is often too large in size. The temperature of the burnt gas is as high as 1300 degrees. C until neat is transferred to the reforming has and it is structurally impossible to decrease the temperature of the burnt gas in order to match the temperature of the heat receiving gas (between 550 and 750 degrees C).

To solve these problems, plate type reformers which are compact in size, and in which uniform combustion all over the combustor is possible to achieve effective reforming, were recently proposed (see for example, Japanese Patent Application Laid Open No. 180136 1987).

A primary object of this invention is to provide a plate typic reformer which enables an effective heat exchange between the burning gas and a raw material gas to be reformed at a lower temperature as hereinbefore possible.

A further object of this invention is to provide a plate type reformer which enables unform fuel success to the combustion os wild as structurestep combustion.

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Fig. 1

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Fig. 2

to a cross sectional view of Fig. 1 as assembled. Fig. 3 and Fig. 4

Buetrate temperature distributions of combustion pas and reforming gas between the modiand the nutlet of the reforming reactor buring heat recichange, rescientives.

Fig. 5

is a croce section view of another embly diment at its central part

As described in Fig. 1 and Fig. 2, a single segment of a plate type retermer of this invention mainly comprises two main units 1, in which a reforming reaction and a combustion take place, and time auxiliarly and 11, through which feel fair combustion is supplied to the main units 1, with the auxiliary unit sandwiched by the niam units 1 and the main units 1 being symmetrical to each other. Holders 10 and 12 are located on the exposed sides of the main units 1, respectively.

The main unit I includes a reforming plate 14 in which a reforming reactor 16 is provided a combustion plate 18 in which a combustor 20 is provided, and a heat conductive separator or a heat conductive partition wall 22 located between two plates 14 and 18. A central portion of the reforming plate 14 is hollowed out and the hollow or space 16a is filled with a reforming catalyst 24 so as to form the reforming reactor 18. Semilarly to the reforming plate, a central period of the compulsion plate 18 is hellowed out and the hollow 22a defined with the first last or plate 18 is hellowed out and the hollow 22a defined with the first last or plate 18 is hellowed out and the hollow 22a defined with the first last or plate 18 is hellowed out and the hollowed out and the hollowed securition catalysts 18 is seen as the first transfer of the combustion catalysts 18 is seen as the first transfer of the combustion catalysts 18 is seen as the first transfer of the combustion catalysts 18 is seen as the first transfer of the combustion catalysts 18 is seen as the first transfer of the combustion catalysts 18 is seen as the first transfer of the combustion catalysts 18 is seen as the first transfer of the combustion catalysts 18 is seen as the first transfer of the combustion catalysts 18 is seen as the first transfer of the combustion catalysts 18 is seen as the first transfer of the combustion catalysts 18 is seen as the first transfer of the combustion catalysts 18 is seen as the first transfer of the combustion catalysts 18 is seen as the first transfer of the combustion catalysts 18 is seen as the first transfer of the combustion catalysts 18 is seen as the first transfer of the catalysts 18 is seen as the first transfer of the catalysts 18 is seen as the first transfer of the catalysts 18 is seen as the first transfer of the catalysts 18 is seen as the first transfer of the catalysts 18 is seen as the first transfer of the catalysts 18 is seen as the first transfer of the catalysts 18 is seen as the first transfer of the

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In the piecof these main distant and the autoiar, unit II the numbustor plates to of the main units I are incated to contact with the upper and mwer dispension iplated 34 of the auxiliary unit II. recpectively. The upper holds: 16 and the lower holder 12 for the panawish of the upper main on til the admitiary upst It, and the lower main unit flure fasteried by polits and nuts, or the like (not shown)

The upper holder 10 has an inlet opening 36 for run material gas to be reformed (CH₄ + H₂O). and an outset opening 36 for the reformed gas (11, CO:) The inlet 36 communicates with the reforming reactor 16 is the reforming plate 14 located thereunder, and the raw material gas to be reformed is supplied to the reforming reacturing in the lower main unit I hirough bores 40 formed within the partition plate 22, the combustion plate 18, the dispersion plate 34, and the distance plate 30. The gas so reformed flows through openings 42 formed within the partition plate 22, the combustion plate 18 the dispersion plate 34, and the distance plate 30 so that it encounters the gas reformed in the reforming reactor 16 in the upper main unit I and proceeds to the outlet opening 33 at the upper holder 10.

The lower holder 12 has an air inlet 44, a fuel inlet 46, and a burnt gail outlet 48. Air through the air inlet 44 is supplied to the combustion chamber 20 in the combustion plate 18 through openings 50 provided in the reforming plate 14 and the separafor 22 of the lower main unit I, and then from that combustion chamber 20 the air is supplied to another combustion chamber 20 in the upper man unit I through openings 50 of the upper and lower dispersion plates 34 and the distance plate 30

Fuel through the fuel inlet 46 is supplied to the scooped spalle 28 of the distance plate 30 via openings 52 bored within the reforming plate 14, the partition plate 22, the combustion plate 18, and the dispersion plate 34 of the lower main unit 1.

Exhaust gas generated in the combustor 20 in the upper main unit I flows through holes 54 formed in the dispersion plates 34 and the distance plate 30 and encounters the exhaust gas generated upon combustion in the combustion chamber 20 of the lower main unit I. After that those exhaust gases are discharged from an exhaust opening 48 through holes 64 provided in the lower partition plate 22 and in the lower reforming plate 14

In the accommensated system, cirils supplied through the air inset 44 whole fuel is superfied

through the row what 46 m the lower harder 10 and raw material gas to be returned forth in the Oviss succeed through the Was meet 36 in the opport re dec 11

The girl with A the English #4 \$950 with roks 50 and the some other of a the upper and magnificant after the disease of the should space 26 in the dictar to place 30 from the facilities da jo pla jowan nostan 10 min olym tha fun passaga two or the man email and then the figer flows better the scended scale 15 improping through the pores 3. If the upper and lower dispersion seates 34 into the Locci and Diam or signistive 20 rest to the dispersion places 64. The fool is benied with the computation cateryst Of in the commitmentors 20 and the resulting exhaunt gas in discharged from the embast gas cotet 48 of the folder 12 through treatment 54

On the other hand the raw material gas to the reformed and supplied from the what 30 of the opper holder to flows into the retouning reactor 16 of the uption main unit I and a part of the gas turner flows into the reforming reactor 16 of the lower main unit I through the hilles 40. This fuel gas is heated by the gas which has been burned in the combustor 20 and reaches the reaction charmber 16 through the segurator 22, and is reformed to H, and CO, with the reforming catalyst 24 in the reforming chamber 16. The gas thus reformed is delivered outside the unit from the reformed gas outlet 38 at the upber holder 10 via the openings 42

In the reforming process mentioned above, this system can be made compact because the reforming reactor 16 is located adjacent to the combustor 20 with the separator 22 disposed between the reforming reactor 16 and the combustor 20 so that the reforming reactor 16 may be heated up by the burned gas generated in the compustor 20

Since the fund hows through the scouped space 28 of the distance plate 30 and the pores 32 of the discersion plate 34, it spreads uniformly throughout the combustor 20, and the combustion of the fuel takes place gradually or step by step, lowering the combustion temperature compared with conventional systems. It is possible to adjust the combustion temperature required by the heat receiving gas by controlling the size and the pitch of the pures 32 in the dispers on clate 34.

Fig. 3 and Fig. 4 depict temperature distribution curves of burnt gas and heat-receiving refurmed gas between the entrance and the exit of the reforming realition and combustor, in which "X" indicates a temperature distribution curve of compristed gas, and "a" indicates the distribution curve of the gas reformed autording to the present invention while 121 is the temperature distribution durve of the gas complication is a conventional system.

Fig. 3 depicts distribution varies of the case where the theat exchange between computing gas and heat receiving the minippigas to performed by parallelings from in flow) and Fig. 4 depicts the base of country for Alexandrian to the Fund. 2 the temperature of the contained but in the first ventional symbol is as if prices the entering which accurring to the present in entering to the contained gas temperature at FSC 3 at the entering and ESC 3 at the entering the temperature distribution cover X 3 his means that a lower temperature can be used in the present invention.

Fig. 5 shows abortion embodinisht of the present invention. This embodinisht basis als, identical with the example is ultrated in Figs. 1 and 2, has two persus plates 60, cause contacting to the combustor 20 side of dispersion crate 34 of the auxiliary until 15. this lever pie, the function of the purpose plate 60 is to further disperse the fuel flowing into the combust in 20 from the purpose 32 of the dispersion plate 34. In other words, if the size and the pitch of the points 32 in the dispersion plate 34 are determined so as not to be affected by pressure fluctuation of the fuel the pitch becomes too large and a uniform fuel dispersion is difficult to realize. In such a case, the purpose plate 60 effectively serves to make the fuel much timer.

The present invention is not rectricted to the above-mentioned examples but, for instance, the positions of the passages for air, fuel, etc. and of each inter-outlet opening for fuel, the reformed gas, etc., may be changed from the positions shown in the figures. The numbers of layers of the main unit may be more than two and accordingly, the number of auxiliary units will be increased.

Claims

1. A reformer including a reforming reactor (18min which a raw material gas undergoes a reforming reaction in the presence of a catalyst and fuel gas is burned so that the reforming reaction temperature may be maintained at a proper level, and the burnt gas may indirectly heat the raw material gas in the reforming reactor (16), characterized in that said reformer comprises: a plurality of main units (I), each main unit (I) including a combustor (20) filled with combustion catalyst (26) and a reforming reactor (16) filled with reforming catalyst (24, with a heat conductive partition wall (22) being sandwiched between the combustor (20) and the refining reaction (16) an auxiliary unit (III). including a distance plate 600 which has a valuant floor chamber (29) and two pergus purpose (64) san two ning the lauthorner, atc. (30) per purpose alter 34 to ming as fee distributurnigistes for unitermity supplying the fuel into Pair contrastor (20 of Warr mark until wherety the reference, realths (16) of the man untrolling et al. restet the combile ong the of the man arts of tamp to be offer la. t. cardwid the automorphism twent the man units its or an passage (44) \mathfrak{h}_{n} for supplying and complete with $\mathfrak{h}^{2}\mathfrak{h}_{n}$ and suralist passage (48,54, thr descharging the gue clomed in said climbustor (20), a foet gud classings (40 40) the supplying fuel gas for reneway to the referency reactor (16), a gat discharge passage (40, 38) for inscharging the que which is reformat, and a fuel passage .46. (2) for subplying the facility said fact chamber 18 a the caseager (36 %8 40 42 44 48) 45 50, 52, 54 being formed within the main and askindry shirts in Hi

- Includerment of claim, in characterized in that the main profits 0 and include 0 both sides of the authory unit (II) in a way that the combustion (20) of cach main unit (I) faces the auxiliary unit (II), and two holders (10, 12) are provided at the excessed sides of the main units (I), so that all the units (I, II, I) between the holders (10, 12) are olded together as a single unit.
- 3. The reformer of claim 1 or 2, characterized in that the main unit the includes a reforming plate (14) in which the reforming reactor (16) is formed, a combustion plate (18) in which the conductor or a combustion chamber (20) is formed, and a heat conductive partition plate (13) which is sandwiched between the reforming plate (14) and the combustion plate (18).
- The referred of claim 3, characterized in that
 the referring reactor (16) includes the referring
 orgiplate (14) which is included out at the
 center thereof, the hole wid space (16a) being
 tiled with the referring catalyst (24).
- The reformer of claim 3 or 4, characterized in that the compustor (20) includes the combustion plate (18) whose central portion is hollowed out, the hollowed space (20a) being filled with the combustion catalyst (26).
- 6. The reformer of any one of the foregoing plaims, characterized in that the auxiliary unit (II) includes a distance plate (30) which has a scocped space (28% that surves as a fuel supply character (28) and two dispersion plates (34, 34, 34) disposed on total subject the distance class a plana to of correct being formed in the tippers in court (34, contract tool or supplied treatment (28%), the

complete for of the lands ontin an location.

- 7. The refurmency is not characterized in that the main unit of a stage ethic a manner curt man the combinant (2000) for man unit obtains the combination of the manual transmitters about the properties of are of 4 manual transmitters of the combination of the manual deviction of the unit of the manual deviction at the unit of the manual deviction are entent.
- 8. The retainment plant 1, characterized in that the raw material past alst 1904 and the resturned gas but if (28 are filmed in one hader (10), and that supply and discharge pastages (40, 42), for raw material gas to the starmed and for the retainmed gas are formed at the that consumitive partition wall (20), in the combustion plate (18), in the distance chater (30), and in the discersion plate (34) of the auxiliary unit (9).
- The returner of Carn 7, characterized in that the inlet openings (44, 46) for combustin air and fuel gas, and the outlet opening (48) for the combusted gas are furned in the other holder (12) that a supply passage (50) for combustion air and a discharge passage (54) for the exhaust gas are formed in the heat conductive partition wall (22), in the reforming plate (14), in the distance plate (30) and in the dispersion plate (34) of the auxiliary unit (4). and that a supply passage (52) is firmed in the compaction plate (18), in the heat conductive partition wall (22), in the reforming plate (14), and in the dispersion plate (34) of the auxiliary unit (ib. so as to allow the fuel gas to flow into the scorped space (28) of the distance platé (30)
- The returner of claim 6, characterized in that a porpus plate (60) is provided on the combustor (20) side of the dispersion plate (34) in the auxiliary unit (II).

Revendications

1. Reformeur comprehant un réacteur (16) de reformage dans leque une matière gazeuse brute subit une réaction de reformage en préserce d'un catalyseur et un gaz combustible est problé afin que la température de la réaction de reformage puisse être maintenue à un niveau apprionné et que le gaz brolé puisse chauffer indirectement la matière gazeuse tirute dans le rélation (16) de reformate la caracterisé en de tune le modification (16) de reformate la caracterisé en de time en modifies de nature unité tirutique et comprehense.

prenunt un élèment de la ma paper. Dé le mo dur data seem 120- d- roynd Lettin et un meisway the performable remail dian cara which \$4) go refirmage, une closero 30% composito A spyria chambrétait brigher Camité of Hody a terpor 20 de l'impostat et la maissa international production and are Lumbrucker une plaque décartement (80) qui presente una chamitre Pore 198 (Elean suctible s et deux pradbes boredses (64 precant er salpwitt tuplaque détamment 30 les cadurc influence (34) servant de claude. Dy as of them, in the committeetable is not mitted time unformement le Combostible dans chause élément (20) de combaglian de chaque unité prinopak iti de manéré gue es planteurs. 🏗 do no rimage des un tés ponupares (° sisent -Hauffés de tagon égale, les éléments de coirpostion (20) des unités principales (I) se faisant face niutuellement afin de préndre en santwith fromté pavelaire (Illi entre les unites conse paies (I), un pascage d'air (44, 50) pour amoner de l'air audit élément (20) de combustion : un passage d'échappement (48, 54) destiné à décharger le gaz brûlé dans ledit élément (20) de cómbustion , un passage (38, 40) de gaz combustible pour amener du gaz combustible pour le reformage au réacteur (16) de reformagel, un passage (42, 38) de décharge de gaz destiné à décharger le gaz qui est reformé l'et un passage (46, 52) de combustible destiné à amicher le combustible à ladite chambre (PB) à combustible, tous les passages (36-38, 40, 42, 44, 46, 48, 50, 52, 54) étant folimés à l'inténeur des unités principales et aux liaire (l. lh.

- 2. Reformeur selon la revendication 1, caractérisé en ce que les unités principales (hi sont places sur les deux côtés de l'unité auxiliaire (l) de manière dun l'élément (20) se con bustion de chaque unité principale (l) soit face à l'unité auxiliaire (lb), et deux éléments de maintien (10, 12) sont prevus sur les côtés à découvert des unités principales (h), afin que toutes les unités (i). Il, hi entre les éléments de maintien (10, 12) spient empilées ensemble en un seul bloc
- 3. Reformeur selon la revendication 1 oc 2, carractérisé en ce que l'unité principale (I) comprend une plaque (14) de reformage dans laquelle est formé le réacteur (16) de reformage, une plaque (18) de combustion dans laquelle est formé l'élément de combustion ou une mambre de combustion (00) et une plaque de elementent (00) conductive de la chahor placet propie en seroximit entre la plaque (14) de reformage et la plaque (18) de conduction.

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- 4. Rudit-meur skipr la revendisantr 3 paractérisé en le pue le reacteur 16 de retermiege comprend la biaque 144 de retermiage qui est éunée en étri, contre l'espace évité 10aétainment du l'ataivacur (24 de reformage).
- Herturn von seich ist revend tahlen 6 für 4. Kannasterise en seigen Mähement 20 de dembustion dem diemprend ist paque (18. de complustion dem die partie) centrale lest évidée. Pespade conduction partiel étant rempt du catal, seur (26) de compusition.
- 6. Reformeur secon l'une que conqué dos revendications précédentes, naractérisé en ce que l'unité à villaire. (El comprend une plaque d'écartement (30° dui présente un espace excavé (25) qui sert de chambre (25) d'alimentation en combustible, et deux plaques de dispersion (34, 34) disposées sur renideux côtres de la plaque d'écartement, plurieurs pores étant formés dans la plaque de dispersion (34) afin qu'un combustible soit amené à travers elle de la chambre (28) de combustible à l'élément de combustion de l'unité principale adiacente (f).
- 7. Reformeur selon la revendication 6, caractérisé en ce que l'unité principale (hi est empilée d'une manière telle que l'élément (20) de combustion de l'unité principale (l) puisse être placé à proximité immédiate de la plaque (34) de drupersion et un ce qu'un élément (10, 12) de maintien est imonté sur le côté réacteur de reformage (16) de l'unité principale (I) afin que toutes les unités (I. II. I) puissent être empilées en un élément unique.
- 8. Refermeur seton la revendication 7, caractérisé en ce que l'oritrée (36) de matière gareure brute et la sortie (38) de gaz reformé sont termées dans un élément de maintien (10), et en ce que les passages (40, 42) d'amenée et de décharge pour la matière gazeuse brute à reformer et pour le gaz reformé sont formés dans la paroi de cloisonnement (22) conductrice de la chaleur, dans la plaque (18) de combustion, dans la plaque (30) d'écartement et dans la plaque (34) de dispersion de l'unité auxiliaire (II).
- 9. Reformeur selon la revendication 7, caractérisé en ce que les ouvertures (44, 46) d'entrée pour l'air combiurant et le gaz comb istible, et l'ouverture (48) de sorbe pour les paz brûlés sont filmétie dans l'autre élémient (12) de maintren, en ce qu'un passage (60) d'arrenée pour l'air content et un passage (64) de decharge.

- pour le gabildé-lacuation point foi née dans la part (22) de not sommement opposant le 16 va chaleur dans la lacue (14) de reformade dans la radue (30) dir anement et dann la paque (34) de describit le 16 millione aux-lain (8) et en ce qui en fraccapi delle (lamenée est formé dans la plaque (16) de communistoir dans la part (22) de couponité ment ou du troit de dans la plaque (34) de oppension de l'outé aux lame (84) de oppension de l'outé aux lame (85) de la pradue d'énantiment (30).
- 10. Refermeur soion la revendication 6 caractérisé et lue qu'une place, produce (6) est seé ue sur le côté érément du combustion (20) de la plaque (34) de displaces du person du tans l'unité aux laire (II).

Patentansprüche

1. Reformer mit einem Reformlerreaktor (16), in dem ein Vormaterialgasi ene Reformierreaktion in Anwesenheit eines Katalysators erfährt und Brennstofigas verbrannt wird, so daß die Reformierreaktionstemperatur auf einem geeignetem Pegel gehalten werden und das verbrannte Gas das Vormaterialijas irī dem Reformierreaktor (15) indirekt aufheizen Kann, dadurch gekennzeichnet, daß der Refermer umfaßt eine Anzahl Haupteinheiten (I), von denen jede einen Brennraum (20) gefullt mit Verbrennungskatálysator (26) und einen Reformieri eaktóir (16) gefüllt mit Reformlierkatalycator (24) enthalt, wobei eine warmeleittähige Teilungswand (22) zwischen dem Brehnraum (20) und dem Reformierreaktor (16) angrordnet ist, eine Hilfseinheit (II) mit einer Distanzplatte (31) mit erior fouren Brennstaffkammer (28), ung zwei porose Platten (34), zwischen denen die Distanzplatte (30) Legt und die als Brennstoffverteilungsplatten zum gleichmäßigen Zuführen des Brennstoffs in jeden Brennraum (20) einer jeden Haupteirineit (I) dienen, wodurch die Reformierreaktoren (16) der Haupteinheiten (1) gleichartig erwärmt werden und die Brennräume (20) der Haupteinheiten (I) einander gegenüber stehen, so daß die Hilfseinheit (III zwischen den Haupteinheiten (I) liegt, einer Luftkanal (44, 50) zum. Zuführen von Luft zu dem Brennraum (20), einen Abgaskana! (48, 54) zum Abführer des in dem Brennraum. (20) verbrannten Gäses; einen Brennstliffgackanal (36, 40) zum Zuführen von Erennstoffgas für tas Reformation in den Reformerreaktor (16). ener Galactoria gukata (40, 38, zum Actusren des retermierten Gases, and einen Errentin

etuffkar all 146 - 60 i zum Duführen ides Brehnstoffs in die Brennstoffkammer (168), wobel after Harlan, ide 38 i 40 i 42, 44 i 48 i 48 i 50 i 52, 54) in den Haubr- und Hilbernheiten, fill III ausgebilt det bald

- Reformer rapid Ansord in 1. dadunct gekennzeichnet, daß die Haubright über in auf der Leigen Seiten der Haber met die strangepranet eine daß der Brentraum (20 jeder Haupteinner ib der Haupteinner ib der Haupteinner ib der Haupteinner ib der Haupteinner Seiter der Haupteinnfeiten (1 vongeseher sich so daß als. Einhötten (1 11. zwischen den Hatern (10. 12) als eine einzige Einheit zusammergefählt sind.
- Reformer nach Anstruch it oder 2, dadurch gekennzeichnet, daß die Haupteinheit (I) eine Reformerblatte (14) in der der Reformierreakter (16) ausgebildet ist eine Verbremungsplatte (18), in der der Brennraum oder eine Brennkammer (20) ausgebildet ist, und eine wärmeleitfahige Teilungsplatte (22) zwischen der Reformierplatte (14) und der Verbrennungsplatte (18) entriblit.
- Peformer nach Ansprüch 3, dadurch gekennzeichnet, daß der Reformierreaktor (16) die Beformierplatte (14) enthält, die in ihrer Mitte ausgehöhlt ist, wobei der ausgehöhlte Raum (16a) mit dem Reformerkatalysator (24) gefüllt iet
- Reformer nach Ansprüch 3 oder 4 dadurch gekennzeichnet, daß der Brennraum (20) die Verbrennungsplatte (18) entriält, deren mittlerer Teil ausgehöhlt ist, wobei der ausgehöhlte Raum (22a) mit dem Verbrennungskatalysator (26) defüllt ist.
- 6. Reformer nach einem der vornergehenden Ansprüche dadurch gekennzeichnet, daß die Hilfseinheit (III) eine Distanzplatte (30) enthält, die einer ausgenommenen Raum (28) hat, der als Kraftstoffvorratskammer (28) dient, und daß zwei Dispersionsplatten (34, 34) auf den beiden Seiten der Distanzplatte angebrichet sind, wobiel eine Vielzähl von Poren in der Dispersionsplatte (34) vorgesehen ist, so daß Kraftstoff durch sie hindurch von der Kraftstoffkammer (28) zu dem Brennraum der benachbarten Haupfeinneit (I) geliefert wird.
- Beformer nach Absprüch 6. dadurch gekennzeichnet, daß die Haupteinheit (I) derart gestatiellt ist, daß ihr Beerschaum (20) name der Distiperart buatter (34) angesichhet ist, und daß ein

Haite of (12) auf der dem Ferendern "Etter 18) zigfekandter Seite der Haldteinheit ür befechst ist solltaß alle Behelter (15) bis eine erzige Einheit zusammengeläft sich

- 8. Formed mach Anstruct II dodust gekennzeichnet, daß dur Einthitt (\$0. für das Minnating gar und der Authitt (\$0. für das minnerte Gas in ihren Halter (\$0. ausgebildet sendund daß 20/0ne und At für, kanale (40. 40-10nus zu instemmerende Vernütenstigst und für
 dus intermette Gas in der Warm leittan gen
 Tollenge wand (\$2), in der Vertin hungsplädte
 (\$8) in der Distanghatte (\$0) und in der Distors ung latte (\$4) der Hilfs inhert (II) aungebilder sind.
- 9. Reformer nach Anspruch 7. dadurch gekennzeichnet, daß die Eintrittsoffnungen (44-40) für die Verbrennungsluft und das Erennsteffgas und die Austrittsüffmang (48) für das verbrahre te Gas in dem anderen Halter (12) ausgebildet şınıt dall ein Zuführungskanal (50) für Verbrennungsluft und ein Abführungskanat (54) für das Abgas in der wärmeleitfähigen Teilungswand (22) in der Reformierpfatte (14), in der Distanzplatte (30) und in der Dispersionsplatte (34) der Häfseinheit (II) ausgebildet sind, und caß ein Zuführungskanal (52) in der Verbrennurgsplatte (18), in der wärmeleitfähigen Teilungswand (22), in der Reformlerplatte (14) und in der Dispersionsplatte (34) der Hilfseinheit (II) ausgabildet ist, so daß das Kraftstoffgas in den ausgenommenen Raum (23) des Distanzolatte (30) einströmen kann
- Refurmer nach Anspruch 6, dadurch gekennzeichnet, daß eine pordse Platte (60) an der dem Brannraum (20) zugewahrten Seite der Dispercionsplatte (34) in der Hilfseinheit (III) vorgesehen ist.

FIG.I

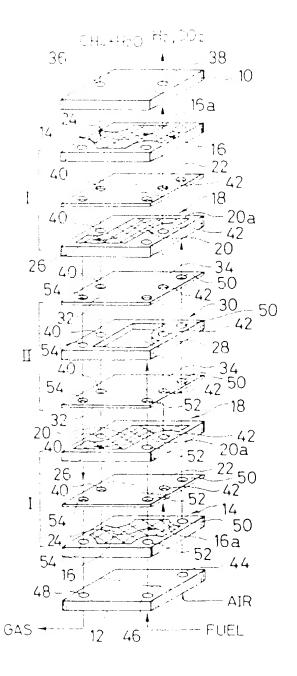


FIG.2

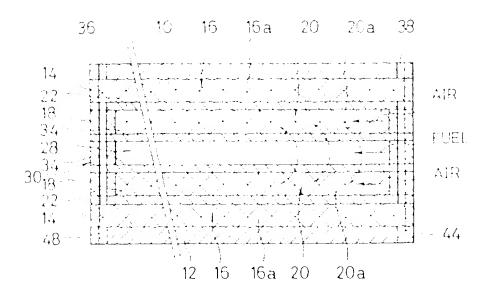


FIG.3

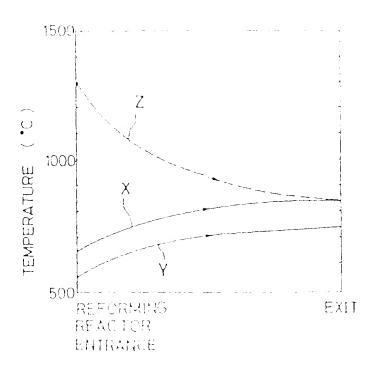


FIG.4

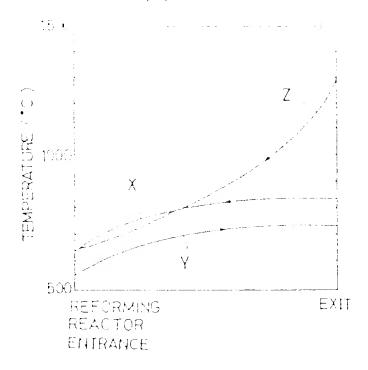


FIG.5

